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Hudson and Berkshire Railroad.

THIS Railroad has been in successful operation since the middle of September last. Two trains pass daily, each way, a distance of thirty-three miles; and the number of passengers and amount of freight thus far, we are informed, much exceed the original estimates.

The grades, in going east from Hudson, are mainly ascending, for near 25 miles; about three miles of which have 70, and a quarter of a mile 80 feet ascent to the mile; yet, with Engines of Norris's manufacture, two of which are on the road, loads of from 60 to 75 tons are taken over these grades without any difficulty; and the apprehensions which were entertained by many of the successful application of locomotive power to these grades, are entirely dispelled.

The ancient city of Hudson is entitled to much credit for its persevering enterprise in completing this work during the late period of embarrassment; and it will most assuredly reap a rich reward, as well from the increased amount of travel as from the facilities for bringing to market the products of the soil, and of the rich quarries of marble and beds of iron.

We should have noticed this work at an earlier period, but were in hopes to have received a full description of its construction, cost, business, &c. &c.; but in the multiplicity of engagements attendant upon the opening and conducting of such a work, the Engineer has omitted to furnish it for publication in the Journal—an omission which we the more readily overlook, as it is presumed the delay will enable him to make it the more complete and satisfactory. Ii shall be published as soon as received.

To Correspondents.—The letter of J. C——r was duly received, and the correctness of his suggestions are fully admitted; and we assure him that the two valuable machines spoken of by him—and others of admitted

value—shall be properly noticed, if he will furnish us with proper descriptions of them.

If we do not as often refer to "new inventions and machines," "as to Railroads," it is because Mechanics are not as prompt in furnishing us with the facts and descriptions, as those interested in internal improvements.

We are very desirous to make the "Journal and Magazine" the medium of communication between inventors and the public, but can only do so when furnished with the means.

[We are much indebted to Mr. Roebling for the following communication—and solicit a continuation of such articles as have been furnished by him and other gentlemen.]

For the Railroad Journal and Mechanics' Magazine.

An Essay on the Obstruction of Streams by Dams; with Formulæ for ascertaining the rise of water caused by their construction. *By* S. A. Roebling, *Civil Engineer.*

When a stream is to be obstructed by a dam, for the purpose of creating a water power, making a slack-water navigation, or feeding a canal, it is a matter of importance to know how high the water will rise above its former level in time of freshets.

Owing to the want of proper investigation, notions contradictory to common sense, have been entertained by professional men on this subject, and the consequence has been, that their works have not realized their expectations. With a view of throwing some light upon this very important subject, the following illustrations and deductions, based upon the theory of *Du Buat* and *Eytelwein*, are offered to the public.

To compute formulæ for the rise of water by dams, it is necessary to know the amount of water discharged by a freshet, the average width of the stream, its average depth and area of cross section.

But the gauging of a large stream in high water is a difficult matter, and at the period when the construction of a dam is to be commenced, there is generally no time to wait for a freshet, for the purpose of making the desired measurements. I would therefore propose, for ascertaining the greatest discharge of water, to gauge the river when at its medium height. For this purpose, let a cross section of the stream be taken, and the velocities of the surface measured at each sounding. It has been ascertained by experiments, that the velocity of water, in streams, *decreases* towards the bottom for every foot depth:

$$0{,}008\,v$$

where v signifies the velocity at the surface. If we now put the depth, for which the average velocity is to be ascertained, equal to h, and denote the required average velocity by v', the we have the velocity at the bottom equal to

$$v - 0{,}008\,v\,h$$

From the surface velocity and bottom velocity we find the average velocity,

$$v' = \frac{v+v-0{,}008\ v.\ h}{2} = v - 0{,}004\ v.\ h$$

$$\text{or,} \quad v' = v\,(1 - 0{,}004\ h)$$

When the average velocity, for each sounding, has been thus calculated, we can find the discharge per second, in cubic feet.

For ascertaining the discharge of a river, in time of a high freshet, let its width equal to l. By dividing l into the area of the cross section which has been measured, we get the average depth of the water, which may be represented by h. The area of the profile, divided into the discharge, gives us the average velocity of the whole section, which may be represented by v. The average velocity of a stream in different stages of the water, are, according to Buat and Eytelwein, as the square root of the different average depths.

Now, let us represent the average velocity of a cross section of a high flood by v' and the average depth of that section by h'

$$\text{Then is} \quad v : v' :: \sqrt{h} : \sqrt{h'}$$

$$\text{therefore,} \quad v' = v\frac{\sqrt{h'}}{\sqrt{h}} = v\sqrt{\frac{h'}{h}}$$

The average velocity of a high freshet, thus found, multiplied into the area of its cross section, gives us the required discharge.

The above method should be applied, if the necessary measurements can be taken, when the stream is at or near its medium height. Without those data, however, an approximate result can be obtained by the formula:

$$v = 90{\cdot}9\sqrt{\left(\frac{a}{p} \times \frac{h}{l}\right)}$$

where v is the average velocity in feet per second, a the area of the profile in superficial feet, h the fall of the river for a certain length l in feet; p signifies the perimeter of the profile, not including the line of surface.

The product of the area into the velocity, thus found, will give the required discharge. This formula, however, cannot be relied on when the stream is irregular; it applies with accuracy only to smooth and regular channels and to canals.

The velocities with which water is discharged through a horizontal opening in the side of a vessel, are according to the laws of gravity, in proportion to the square roots of the respective heights of the columns of water above the orifices. The pressure, which the particles of water support at a certain depth, is proportionate to the velocity with which they tend to escape. This velocity is hypothetically equal to that acquired by bodies falling through the same space. The velocity of a body, acquired at the end of the first second of its fall is $= 2 \times 16{\cdot}1 = 32{\cdot}2$ feet, and if we denote the different velocities by v and V, and the respective heights by h and H, then according to the laws of gravity

$$\text{is} \quad v : \mathrm{V} :: \sqrt{h} : \sqrt{\mathrm{H}}$$

$$\text{and} \quad \mathrm{V} = \sqrt{\frac{v^2\,\mathrm{H}}{h}}$$

If we take $v = 32{\cdot}2$, and $h = 16{\cdot}1$, we have:

$$\text{I.} \quad V = \sqrt{\frac{32{\cdot}2^2\ H}{16{\cdot}1}} = 8{\cdot}024\ \sqrt{H} \quad \text{and}$$

$$\text{II.} \quad H = \frac{v^2}{8{\cdot}024^2} = 0{\cdot}0155\ V^2$$

The quantity 8,024 is called the hypothetical co-efficient for falling bodies, and this co-efficient will be here generally denoted by the letter α. In applying the above rule to the motion of water, the case is somewhat different under different circumstances. Du Buat and Eytelwein have made a number of satisfactory experiments to fix co-efficients for the velocity of water in different circumstances.

According to these experiments, for instance, the value of the co-efficient for the discharge of water over a waste weir, of common construction, is found to be - - - - - - = 5·7

For large and well constructed dams, where all circumstances are favorable to the discharge, - - = 7·5

Before we can proceed to demonstrate the discharge of water over dams, we have to examine the laws under which water generally will be discharged, when under acertain head.

The annexed diagram represents a vessel, Q R, filled with water up to A. Suppose that sufficient water is flowing in to keep the surface at the same level, and that there are several small openings, P, E, B, above each other in the vertical line A B, in one side of the vessel.

The jets of water streaming through the opening P, E, B, are represented by the horizontal dotted lines, P M, E H, B G.

Let us put A P $= x$; the velocity with which the water rushes through the opening P, be $= y$; and the co-efficient of this velocity be $= \alpha$.

So is, by formula I,

$$y = \alpha\ \sqrt{x}.$$

The same is applicable to every other opening B, with a head of pressure = A B; and if we denote A B by h, and the corresponding velocity by v, we have

$$v = \alpha\ \sqrt{h}$$

Now let $\quad PM = \alpha\ \sqrt{x} = y$

and $\quad BG = \alpha\ \sqrt{h} = v$

Then is $\quad AP : AB :: x : h$

and $\quad PM : BG :: \sqrt{x} : \sqrt{h}$

or $\quad PM^2 : BG^2 :: x : h$

Therefore $\quad AP : AB :: PM^2 : BG^2$

The same is true for every other absciss and ordinate, as A P, and P M, and from this it follows, that the curved line A M H G, which is formed by the extreme points M, G, &c. of the dotted lines, representing the velocities of the water-jets, forms a *Parabola*. If we now imagine the

vertical line A B consists of a great number of such small openings, than the amount of water, or the sum of all the water-jets, may be represented by the area of the parabola. The superficial content of the parabola A B G is

$$= \tfrac{2}{3}\, A B .\, B G = \tfrac{2}{3}\, v\, h$$

If we denote the width of the perpendicular narrow opening or slit A B, by l', the amount of water discharged through this slit will be

$$= \tfrac{2}{3}\, l' .\, v .\, h$$

Now, suppose the great rectangular opening, A B C D, consists of a large uumber of such vertical openings, and let be

$$A C = B D = l$$

and the discharge through that rectangle = Q, then we have

$$Q = \tfrac{2}{3}\, l\, v\, h$$

and by substituting for v, its value $= \propto \sqrt{h}$, we have the discharge per second, or

$$\text{III.} \qquad Q = \tfrac{2}{3} \propto l\, h \sqrt{h}$$

$$\text{and} \qquad h \sqrt{h} = \frac{Q}{\tfrac{2}{3} \propto l} \text{ or } h^3 = \left(\frac{Q}{\tfrac{2}{3} \propto l}\right)^2 \qquad \text{or}$$

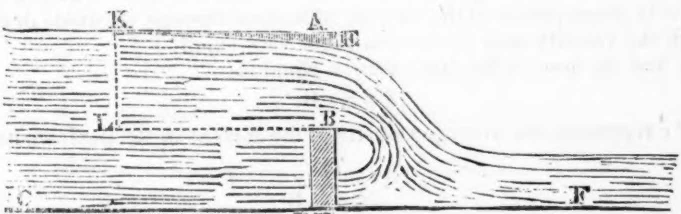
$$\text{IV} \qquad h = \left(\frac{3\, Q}{2 \propto l}\right)^{\frac{2}{3}}$$

In investigating the state of water, when obstructed by dams, three different cases present themselves.

I.

When a dam serves only as a waste-weir, and the pool above it forms an extensive sheet of water, the surface of which is kept at the same level, without any perceptible current.

In the annexed diagram, B D represents the dam or weir; the line K A, the level of the upper pool; and C F, the bed of the river or reservoir, corresponding to the average depth of the water.



The body of water, discharging over a dam, will sink considerably below the level of the surface of the pool, before it reaches the breast of the dam, forming a curve tangential to the surface of the pool.

The formulæ III and IV apply to this case exactly. The height h, or the head of the fall, is in the diagram represented by the lines K L = A B, the elevation of the surface above the top of the dam.

If we, therefore, know the quantity of discharge per second, we find by the formula IV the height corresponding to it; and if the height is known, we find the discharge by formula III.

The height of the water above the edge of the dam, or B E, and the contraction of it below, is here not taken in consideration, as it is of no practical use.

2

When, as in the first case, the comb, or top of the dam is above the surface of the lower pool, and the water in the upper pool arrives at the head of the fall with a certaln velocity.

With reference to the above diagram, let us term the point K in the surface of the upper pool, where the water is horizontal, or nearly so, or has yet about the same inclination as the pool farther up, the *head of the fall.*

The elevation of this point B above the top of the dam, or A B, may be denoted by the letter - - - - - - -	h
The height of the dam, or B D, by - - - - - - -	K
The average width of the pool, by - - - - - - -	B
The length of the dam, by - - - - - - - - -	l
The quantity of discharge over the dam per second, in cub. feet, by	Q

The line C F represents the bed of the river, (corresponding to the average depth) as well as the base of the dam, and all the heights are calculated from it.

If we now suppose the upper pool forms a still water without any current, then we have the former case, and if we represent the fall, or A B, by the letter h', we find according to formula IV

$$h' = \left\{\frac{3\,Q}{2\,\alpha\,l}\right\}^{\frac{2}{3}}$$

But in the present case the water arrives at the head of the pool, with a certain velocity due to the current in the river above the pool, and this velocity comes to the aid of the velocity of discharge, caused by the height of the fall.

The velocity of the discharge is therefore equal to the velocity, due to the height of the fall. plus the velocity, due to the current of the pool. But the quantity of discharge remaining the same, and the velocity being increased, the height of a discharging body of water will be reduced in a proportion corresponding to the increased velocity. The water in the pool, is in consequence of the current in motion through its whole depth, though the velocity near the bottom is but very small.

We find the area of the cross section equal to

$$(h+K)\,B$$

and if v represents the average velocity of the current in the pool, we have

$$v = \frac{Q}{(h+k)\,B}$$

Now, let us represent the height which corresponds to this velocity, by the letter H, then we have, according to formula I,

$$H = 0\,0155\,v^2$$

and by substituting for v its value, we get

$$H = 0{\cdot}0155\left\{\frac{Q}{(h+k)\,B}\right\}^2$$

For finding the true height of the surfaee of the pool above the top of the dam, or the height A B $= h$, we have therefore to deduct the value of H from the value of h', and we arrive at the formula

$$\text{V}' \quad A\,B = h = \left\{\frac{3\,Q}{2\,\alpha\,l}\right\}^{\frac{2}{3}} - 0{\cdot}0155\left\{\frac{Q}{(h+k)\,B}\right\}^2$$

And if we put the co-efficient $\alpha = 7{\cdot}5$ and $B = l$, we have

$$\text{V} \quad h = \left\{ \frac{3\,Q}{15\,l} \right\}^{\frac{2}{3}} - 0{\cdot}0155 \left\{ \frac{Q}{(h+k)\,l} \right\}^2$$

This formula contains in the subtractive member the value of h itself. As this term of the equation, however, is comparatively small, it will be sufficiently correct in practice, to find the value of h by approximation, without making the formula more intricate by further reduction.

Example 1.

Suppose a dam of 500 feet long and 11 feet high, has been constructed across a river of the same width, the average depth of which in time of a high freshet is 10 feet, and its discharge at the same time 25,000 cubic feet, per second. How much will the water rise above the top of the dam, if all circumstances are favorable to the discharge, and the co-efficient α is put $= 7{\cdot}5$?

The above formula for h, is here

$$h = \left\{ \frac{3{\cdot}25000}{15\;500} \right\}^{\frac{2}{3}} - 0{\cdot}0155 \left\{ \frac{25000}{(h+11)\cdot 500} \right\}^2$$

Now, let us assume $h = 4{,}5$

$$\text{then is} \quad h = \sqrt[3]{100} - 0{,}0155 \left\{ \frac{25000}{15{,}5\;.500} \right\}^2$$

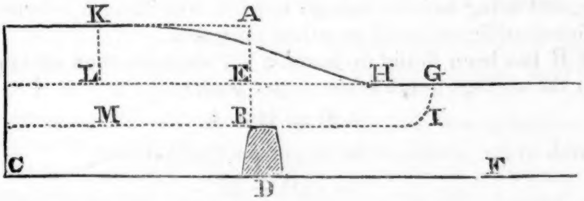
$$\text{or,} \qquad h = 4{,}641 - 0{,}161$$

$$\text{therefore,} \qquad h = 4{,}48 \text{ feet.}$$

This result is near enough to the assumed value, and therefore sufficiently correct.

3.

When the top of the dam is lower than the surface of the lower pool, and the water in the upper pool arrives at the head of the fall with a certain velocity.



The annexed diagram may respresent the case in question, and we will represent the depth of the river below the dam, or E D, by the letter - - - - - - - - - - h

The height of the fall from the upper level to the lower level, or A E, by - - - - - - - - - - H

The height of the dam, or B D, by - - - - - - K

The length of the dam, or width of the river, by - - - l

The quantity of water discharged per second, by - - - - Q

The line C F may represent the bed of the river corresponding to the average height h of the water.

To simplify the demonstration of this case, let us suppose the water in the upper pool form a perfect level without current, and not consider the

effect which the whirl below the dam, caused by the fall of the water, has upon the discharge.

The quantity of water discharged through the height A E, will then be found by formula III.

$$= \tfrac{2}{3} \alpha \, l \, H \sqrt{H}$$

The body of this water above the level L E presses upon the body of water below, included between the dotted lines L E and M B, which, therefore, will be forced to pass off through the height E B.

Let us now imagine a pipe E H G I B, of the width of the river, and the height E B resting on top of the dam, with one vertical opening E B at the dam, and another horizontal opening H G at the surface of the lower level, below the fall. The body of water included between the lines L E and M B, would then pass through this pipe, and be discharged at the surface of the lower level with a velocity corresponding to the pressure of the water above, or due to the height A E. The velocity of the water flowing through the height E B is therefore found, according to formula I

$$= \alpha \sqrt{H}$$

and the discharge

$$= E\,B.\,l.\ \alpha \sqrt{H} = \alpha \, l \, (h - k) \sqrt{H}$$

The kischarge through the height A B is equal to the sum of discharges through A E and E B, and therefore

$$Q = \tfrac{2}{3} \alpha \, l \, H \sqrt{H} + \alpha \, l \, (h - k) \sqrt{H} \qquad \text{or}$$

$$\text{VI} \qquad Q = \alpha \, l \, (\tfrac{2}{3} H + h - k) \sqrt{H}$$

and from this we find

$$\text{VII} \qquad H = \frac{Q}{\alpha^2 \, l^2 \, (\frac{2}{3} H + h - K)^2}$$

The value of H must be found here by approximation, as in formula V.

With respect to the velocity of the current in the upper pool, Mr. Eytelwein offers a formula for the value of H, the application of which is very difficult on account of its perplexity. The following demonstration, however, will bring us near enough to truth, and furnish a formula which will be found sufficient to all practical purposes.

When H has been found by formula VII, we have then an approximate value for the average depth of the upper pool, or

$$A\,D = H + h$$

The area of the profile of the upper pool is therefore

$$= l\,(H + h)$$

From this we find the average velocity of the current in the pool

$$= \frac{Q}{l\,(H + h)}$$

which velocity is owing to the current of the river above, independent of the fall of the water over the dam.

According to formula II, we find the height, corresponding to this velocity

$$= 0{\cdot}0155 \left\{ \frac{Q}{l\,(H + h)} \right\}$$

which ought to be deducted from the value H in formula VII, as we have done in case No. 2, in order to arrive at the true height of the fall.

We therefore arrive at the formula

$$\text{VIII} \quad H = AE = \frac{Q^2}{\alpha^2 l^2 (\frac{2}{3}H + h - K)^2} - 0{\cdot}0155 \left\{ \frac{Q}{l(H+h)} \right\}^2$$

The objection can be made against this formula, that the current of the upper pool may be reduced by the resistance of the water below, and that then the value of H is found too small.

To examine this question, we must distinguish several cases. The first case is, when a dam forms a breast-dam, with no lower slope. The falling water will here produce a whirl, the effect of which will not extend far below the dam, and will have little influence on the current of the tail-water. The second case, when the dam has a long slope forming an inclined plane, or better, an inverted parabola, on which the water glides down. The lower body of water, after having moved down the slope, shoots off in a more horizontal direction, not affecting the bed of the river immediately below the dam, but pushing ahead the tail-water, the current of which consequently will be increased. Without reference to the form of dams, other considerations present themselves with respect to the depth of the water. When the river is not deep, and the lower level but little above the top of the dam, the escape of the tail-water will be increased by the mechanical momentum, produced by the *height of the fall* of the water, rolling down the slope, and the resistance offered to the current of the upper level, will be therefore decreased. On the other hand, when the dam is very low and the water very high, the momentum of the falling water will be increased proportionably by the *general increase of the velocity* of the river, and will therefore also increase the velocity of the tail-water below the fall, so as not to resist the current above.

It appears, therefore, that we may apply the above formula, without any deduction, in all cases *favorable* to the escape of the tail-water. When the construction of the dam, and the features of the river, however, are *unfavorable* to the discharge of the tail-water, then we must reduce the value of the subtractive member of the formula.

The value of the co-efficient α should be fixed with reference to the construction of the dam, and to the nature of the pool above the dam.

When a dam serves as a waste-weir, and the pool above the dam, forms proportionally an extensive sheet of water with no current, then the value of α is found, according to Du Buat and Eytelwein, to be $= 5{\cdot}70$

For a dam in a small stream, with no wing-walls and embankments confining the current, we may put α . . $= 7{\cdot}00$

For a dam in a large river, with wing-walls and high embankments, leading the current fairly to the fall, we may put α . . . . $= 7{\cdot}50$

Example 2.

A river is 500 feet wide, its average depth in time of a freshet is 10 feet, and its discharge at the same time 25000 cubic feet per second. A dam of 500 feet long, and 7 feet high, has been constructed across the river. How much will the water be raised above its former level, or how much is the height of the fall from the upper level to the lower level?

The co-efficient α be here $= 7{\cdot}5$.

By applying the formula VIII, and substituting the above data, we have

$$H = \frac{25000^2}{7{,}5^2 . 500^2 (\frac{2}{3}H + 10 - 7)^2} - 0{,}0155 \left\{ \frac{25000}{(H+10) . 500} \right\}^2.$$

Let us assume $H = 2,00$; then we get

$$H = \frac{44,44}{(\frac{2}{3}.2+3)^2} - 0,0155 \left\{ \frac{25000}{12.500} \right\}^2$$

$$\text{or} \qquad H = \frac{44,44}{18,775} - 0,0155 . 17,361$$

$$\text{or} \qquad H = 2,367 - 0,269 = 2,098 \text{ feet.}$$

which result is near enough to the assumed value of H, and therefore sufficiently correct.

EXAMPLE 3.

A dam of 800 feet long, and 6 feet high, is to be constructed across a river of about the same width, and which in time of a high freshet discharges 60,000 cubic feet per second, and has an average depth of **16** feet. **What will be the height of the fall, or the value of H, if we put $\alpha = 7{\cdot}5$?**

Let us assume the value of $H = 0,8$, then we have

$$H = \frac{6000^2}{7,5^2.800^2\,(\frac{2}{3}.0,8+16-6)^2} - 0,0155 \left\{ \frac{60000}{16,8\,.\,800} \right\}^2$$

$$\text{or} \quad H = \frac{100}{(0,533+10)^2} - 0,0155 \left\{ \frac{60000}{13440} \right\}^2$$

$$\text{or} \quad H = \frac{100}{110,944} - 0,0155 . 19,927$$

$$\text{or} \quad H = 0,901 - 0,3088 = 0,593 \text{ feet.}$$

This result does not agree with the value assumed for H, and is too **small.** From the nature of the formula it follows, that we must assume a smaller quantity for H. Let us therefore put $H = 0,6$, and we have

$$H = \frac{60000^2}{7,5^2.800^2(\frac{2}{3}.0,6+10)^2} - 0,0155 \left\{ \frac{60000}{16,6\,.\,800} \right\}^2$$

$$\text{or } H = \frac{100}{(\frac{2}{3}.0,6+10)^2} - 0,0155 \left\{ \frac{60000}{13280} \right\}^2$$

$$\text{or } H = \frac{100}{108,16} - 0,0155 . 4,158^2$$

$$\text{or } H = 0,924 - 0,316 = 0,608 \text{ feet.}$$

This result agrees well with the assumed value of H, and is therefore sufficiently correct.

Remarks on De Pambour's Formula, in reply to Mr. E. F. Johnson.

MESSRS. EDITORS—I notice, with some surprise, in the 8th number of your Journal, an attempt by Mr. E. F. Johnson to evade the charge of having attributed in his letter of April 7th, the errors in the table of the power of Locomotive Engines, submitted by him to the Directors of the New-York and Erie Railroad Company, to an alleged inaccuracy in De Pambour's formula, and an insinuation that I have asserted that charge in my communication of June 15, without any just grounds. This attempt is as futile as the insinuation is false; for the whole object and

tenor of Mr. Johnson's letter was, to excuse the errors in his table, on the ground that the cause of them lay in the formula, and that "owing to the haste" in which he prepared that table, he did not notice at the time the full extent of the defects in De Pambour's formula. This is distinctly expressed in the following extract from Mr. Johnson's letter of April 7. "As to the accuracy of De Pambour's formula within the limits in which it may be considered properly applicable, although I believed it to be nearer the truth than appears on a more critical examination, yet I gave it as my opinion that it was imperfect." And one of those imperfections consists, according to Mr. Johnson, in the fact that the formula in question "does not designate the point at which it ceases to be applicable." We should be glad to have Mr. Johnson show us how that formula could have been arranged, so as to designate its own proper limits. The very nature of the formula makes this impossible, and it must always be left to the judgment of those who employ such formulæ, to know their proper limits. There are many important formulæ in science that contain no term which designates the point at which they cease to be applicable, and are nevertheless perfectly correct.

As to the fact, which Mr. Johnson states, that De Pambour in his practical table, (page 186, Philadelphia edition—page 216, London edit.) has been, in at least one instance, led into precisely the same error with himself and Mr. Talcott, (*i. e.*, has applied his own formula beyond its proper limits, and thus obtained a result where the resistance on the piston is greater than the force that is to move it,) we simply state that *this fact does not exist*, and that the error in De Pambour's table, which Mr. Johnson as well as Mr. Talcott adduce as a precedent, or sort of palliative, for their own errors, arises from an entirely different source, and is in fact nothing more than an accidental omission to subtract the last term of an equation, as we have already shown in our communication of October 9th, in reply to Mr. Talcott. It is evident that De Pambour constructed that table, by first determining the maximum loads of Engines under different pressures, according to the formula

$$M = \frac{(P-p)\,d^2 l}{\varepsilon + n} - \frac{F}{\varepsilon + n}$$

with their corresponding velocities, and did not make use of the formula

$$V = \frac{m\,P\,S\,D}{(F + 9\,M)\,D + p\,d^2 l} \quad \text{or,} \quad M = \frac{m\,P\,S\,D - p\,d^2 l\,V}{9\,V\,D} - \frac{F}{9}$$

which Mr. Johnson employed in the construction of his table, except to determine the intermediate loads and velocities after having fixed the limit of the Engines under given pressures; and the instance where the error occurs is in the computation of the maximum load of an engine.

We never charged Mr. Johnson with any intention of disparaging the labors of De Pambour; we only said that until Mr. Johnson demonstrated to us the alleged defects in De Pambour's "mode of conducting and analyzing his experiments," we should view his formula correct; and if Mr. Johnson will take the trouble to re-peruse our remarks of June 15, he will find that we have done him no injustice, as he conceives, unless, indeed, the pointing out and correcting his errors constitute the injustice, in which case we must plead guilty, and even be unjust enough to repeat the offence.

Mr. Johnson, determined to support the assertion that De Pambour's "mode of conducting and analyzing his experiments" was deficient, favors us with a "critical examination" of some of these defects, and

endeavours first to show that De Pambour has not made the proper corrections in the use of the spring-balance, because he takes into account only, 1st. the pressure produced by the weight of the lever at the place of the valve; 2d, the pressure produced at the end of the lever by the weight of the rod, the screw and spring; 3d, the weight of the disk of the valve. Mr. Johnson then, by quite an inexplicable process of reasoning, establishes that the weight of the plate, tube, and foot of the balance at the end of the lever, must be added to the above parts; in a word, he tells us that *the whole weight of the balance* at the end of the lever should be added to the amount pointed out by the index. Now, on all the Engines we have ever seen, the safety-valve was so arranged, that the foot of the balance with its plate and tube, was firmly attached to and supported by the boiler; and therefore, only those parts, which De Pambour was the first to notice in the corrections to be made to the weight marked by the spring-balance, are all that should be taken into account, notwithstanding Mr. Johnson's incomprehensible demonstration to the contrary.

Mr. Johnson next suggested another correction not noticed by De Pambour, to made in the use of the spring balance resulting from the miter of the valve, by which a greater surface is exposed to the atmospheric pressure than that upon which the steam presses. This error can only exist when the valve is perfectly close to its seat, and then it can never be exactly ascertained, as in that case the spring balance only indicates the pressure of the steam in a *negative* manner; for so long as the valve is perfectly closed, all that we know is, that the steam is of less force than the pressure of the spring balance added to that of the atmosphere. But the instant the valve is raised off its seat, in ever so slight a degree, we then know the pressure of the steam *positively;* but then also the error, which Mr. Johnson points out, ceases to exist; for then the air (owing to its nature as a fluid,) and the issuing steam meet upon the same place of the valve. As in most Locomotive Engines the miter is only $\frac{1}{4}$ of an inch, the extreme error resulting thence, can at most be 3lbs.; for taking a valve of $2\frac{1}{2}$ inches diameter with $\frac{1}{4}$ inch miter, making the upper diameter $2\frac{3}{4}$ inches, we have $\frac{(5{\cdot}930 - 4{\cdot}908) \times 14{\cdot}7}{4{\cdot}908} = 3{\cdot}08$, which is but 4 per cent. upon the pressure at which Locomotive Engines are generally worked, instead of 14 per cent as Mr. Johnson states. This error, however, could in no degree have affected the results of De Pambour's experiments, as in all cases, he invariably verified the pressure indicated by the spring balance, by the mercurial gauge. But Mr. Johnson rejects the use of that instrument in toto, because De Pambour says, that "the steam having to pass through a long and narrow tube arrives on the mercury at a less degree of pressure than in the boiler." Now, De Pambour is very far from disparaging the value of the mercurial gauge, for he says, (page 56, London edition)—" We may therefore easily conceive the great utility of an instrument which at first sight, and by its mere inspection, will give *the exact measure* of the pressure of the steam.

The remarks quoted by Mr. Johnson, and upon which alone he bases his objections to the steam gauge, was thrown out by De Pambour, merely as a suggestion of the great care which is necessary in its use, and the inconvenience attending upon its application to Locomotive Engines. Mr. Johnson forgets entirely that the communication between the boiler and the mercury being uninterrupted, the steam of necessity continues to flow upon the mercury until a perfect equilibrium is established, and the pressure upon the mercury becomes precisely the same as in the boiler.

From these imaginary defects in the spring balance and mercurial gauge, Mr. Johnson concludes that both these instruments should be rejected, as also the proposed portable manometer by De Pambour, and then suggests a new mode of his own for ascertaining the pressure of the Steam in the boiler, which however bears impracticability upon its very face. He "conceives" that the spring balance applied to a cylindrical pston, will have the "peculiar advantage" of giving "the actual pressure without any correction." Every practical man, will see at a glance, that such an instrument would be utterly inapplicable; for the proposed cylindrical piston must be steam tight, and how are we to estimate accurately the friction produced by the piston against the sides of the cylinder?

Mr. Johnson next proceeds to notice what he conceives to be "evidently a defect in the formula of De Pambour," namely, that he assumes the evaporating power of Locomotive Engines as a constant quantity, whereas it varies with the velocity, because of the greater number of cylinders full of steam ejected through the chimney, by which the draught, and consequently the combustion of the fuel is increased. De Pambour was perfectly aware of this fact, and did not conclude to assume the value of "S" as constant without careful reflexion, which satisfied him that there were counteracting causes which in a very great degree balanced or neutralized the increase of the evaporating power by an increased velocity of the engine; and that for all practical purposes, an average power, at a medium velocity, with which the traffic upon most Railways is carried on, would be quite sufficiently accurate. This is evident from his remarks, when treating the subject of the Blast-pipe, through which the steam is rejected. "Thus the power of this additional means will be greater in proportion, as the velocity of the Engine itself will be more considerable. If, for instance, the Engine travels 30 miles an hour, the velocity of the jet will be 195 miles an hour, or 286 feet per second; and as that velocity cannot be produced merely by the tendency of the steam to escape into the atmosphere, a part of the power of the Engine itself must necessarily in great speeds be spent in expulsing the steam; that is to say, in blowing the fire in the fire-place. *Consequently the increase of effect being produced at a sacrifice of power, a point will naturally come where the profit is balanced by the expence required to attain it, and there all advantage will cease.*

This question has also occupied the attention of some of the ablest English writers on the subject of Railways and Locomotive Engines. Mr. Wood, as early as 1832, in the second edition of his work on Rail Roads, in speaking of the relative evaporation of Locomotive Engines at different velocities, says. "But as in this case the piston moves at a correspondingly increased velocity, thereby producing a diminution of effect, and there also being an increase of resistance from the air at greater velocities, perhaps in the absence of experiment to prove the amount of all these forces, *we ought in practice to suppose the power of the Engine constant.*"

But in the third and much improved edition of the same work, (published in London, 1838,) this able and experienced writer treats the same subject much more fully, and examines with his usual good judgment and acumen, the position which De Pambour has taken with regard to the evaporating power of Locomotive Engines; and as Mr. Wood has there expressed, in the fullest and clearest manner, all that we could wish to have said in reply to Mr. Johnson's argument, we may be excused for inserting his remarks here at length.

"As the subject of determining the relative evaporation at different rates of speed, is of great importance in the investigation of the power of these Engines, *we shall in our calculations of the useful results produced in practice, suppose the power of evaporation constantly the same at all rates of speed*, until we have an opportunity of more conclusively determining the evaporation at different rates of speed."

"In adopting this mode of calculation at a medium velocity, we keep below the real powers of these Engines, as when the Engines travel at a greater rate of speed than the average rate adopted, the evaporating power will be greater than that given in this table. *We are the more disposed to come to this conclusion, inasmuch as in our calculations of the powers of these Engines, we have not taken in account the increased resistance of the steam passing from the cylinders, arising from the contraction of the discharging pipe into the chimney, to produce the necessary draught of air through the fire, at different rates of velocity.* These two, will in some degree balance each other; the resistance to the free discharge of the steam into the chimney will increase, as the velocity of the discharge is increased, while on the other hand the degree of evaporation will, likewise, at the same time, be correspondingly increased."

"We have made some experiments to ascertain the resistance arising from the contraction of the blastpipe at different rates of velocity, but these have not been sufficiently varied to produce results on which we could found calculations satisfactory to ourselves; until therefore experiments are made to determine both these effects accurately, at the different rates of speed requisite to form a conrect conclusion, *we shall as before stated, assume the evaporation of the steam by the Locomotive Engines to be constant, allowing the effect of the increase at the higher rates of speed, to be counteracted by the increased obstruction of the steam in its passage through the blast-pipe into the chimney.*"

"Mr. Pambour calculates, that in applying this to practice, we should not take the effective evaporation at more than three-tenths of a cubic foot of water for each square foot of surface, to allow for the waste of steam through the safety valves. the loss by part of the water being thrown out into the cylinders mixed with the steam, and from other causes. *By adopting this as a standard, we are of opinion, adequate allowance is made for the loss by all the above causes.*" (*Vide* Wood's 3rd edition, pages 529 to 531.)

From this copious extract, we see that Mr. Wood entirely adopts the results deduced by Mr. Pambour, after giving them the most careful consideration; not only as regards the propriety of taking the evaporating power of Locomotive Engines as constantly the same under all practical velocities, but also as respects the amount of *effective* evaporating power, or rather the estimate of loss of steam through the valves and other causes, as established by Pambour, not as Mr. Johnson asserts by mere "arbitrary assumption," but from a series of experiments on the rising of the valve. And surely the opinion of no one is entitled to more confidence on these subjects than that of Mr. Wood, who combines with the greatest skill and experience the best opportunities for practical research and investigation.

Thus we think we have fairly, and as briefly, as the nature of Mr. Johnson's arguments would permit, met all the objections raised by him against De Pambour; in doing which we have neither been "over hasty" nor "captious," as Mr. Johnson terms our review of his first communications, but rather exercised a considerable share of patience in following him through the labyrinth of his errors and confused conceptions.

New-York, November 29, 1838. C. E. DETMOLD.

Society of Civil Engineers of the United States.

We have frequently spoken on this subject with gentlemen of the profession. It is generally agreed that the establishment of such a society will be much to the benefit of all its members, as well as to the public generally.

During our late excursion to the South, we received from several Engineers an opinion favorable to the organization of such a society, and we had intended laying this subject before our readers, with a request to them to express their opinion upon the subject.

Before we were able to do so, we received the following communication, which we recommend to the earnest attention of our readers.

We respectfully solicit the opinion of the profession generally upon this subject.

"At an accidental, though somewhat numerous meeting of Civil Engineers, at the city of Augusta, Georgia, it appearing to them that great good might be expected to result to the cause of Internal Improvement, throughout the country, and the usefulness and respectability of the Profession of Engineering enhanced, by a frequent and free interchange of opinions, and the recital of their experience; the following resolutions were adopted:

"Resolved—That for the reasons above recited, the Civil Engineers throughout the country, be invited to convene at the city of Baltimore, on the second Monday in February next, (1839) with a view to the formation of a Society of Civil Engineers of the United States.

"Resolved—That in accordance with the foregoing Resolution, the members of the profession here present, will assemble at the time and place therein specified.

"Resolved—That the proceedings of this meeting be printed in the form of a Circular, and that each of us will use his efforts, by a distribution of the same among the members of the profession generally, to cause a full attendance on the Convention.

Augusta, Ga., October 17, 1848.

Among those present, were Engineers from Massachusetts, Alabama, Georgia, New-York, North and South Carolina, Tennessee, and Kentucky.

Report of the Survey and Examination of a Route for a Railroad from Bridgeport, in the direction of New-York City, to Sawpits Village. By R. B. Mason, *Chief Engineer of the Housatonic Railroad.*

Engineer's Office, Bridgeport, November 22, 1838.

To the President and Directors of the Housatonic Railroad Company:—

Gentlemen,—I respectfully submit, in the following Report, the result of the survey and examination of a route for a Railroad from Bridgeport, in the direction of New-York City, to Sawpits Village.

The survey and measurement was commenced at the junction of Wall and Water streets, in the city of Bridgeport. After passing through the latter street into the outskirts of the city, we pursued nearly a west course crossing the New-York and Boston Turnpike, two miles from Bridgeport, and passing a short distance north of the main street in the village of

Fairfield; thence running parallel to, and near the turnpike, to Mill Creek, and recrossing it near Southport; thence passing by Green's Farms, Cumpo Comers, to Saugatuc River, which our line crosses at a favorable point about one and a half miles south of Westport; thence pursuing nearly a direct line to Norwalk river, at Old Well, the east bank of which is fourteen miles from our starting point. The most prominent point of expense, in grading this part of the line, occurs at a high ridge crossing our course nearly at right angles between the Saugatuc and Norwalk rivers. In crossing this ridge, we adopted a grade of 40 feet per mile, which is our maximum grade, and is not considered objectionable, as it seldom exceeds a mile in distance at one point, and can generally be located on a very direct line.

A portion of the expense in crossing this ridge may be saved by ascending diagonally along its eastern slope, and crossing a little farther south.

From Norwalk river, our course was nearly south-west, for about one mile, gradually ascending to the top of a ridge, thence descending to Five Mile river, which we crossed about a half a mile north of the landing. In crossing the ridge between Norwalk and Five Mile river, there occurs another expensive point in grading, having a cut of forty-two feet at the highest point; the ridge, however, is very short, as it falls below our grade on each side, in a distance of ten chains from the summit. From a subsequent examination by the eye, I found this ridge descended rapidly towards the Sound, and might be crossed about a half a mile farther south, on a lower grade, and with less cutting. From Five Mile river, our line was conducted to the Short Rocks, about one mile in advance, which at first presented a very forbidding appearance, but upon mature examination a route was discovered near the Salt Marsh, avoiding almost entirely all rock cutting, and introducing us, by a short cut of fourteen feet, to Good Wife's river, which our line crossed about ten chains north of Darien Landing. In our course thence to the village of Stamford, we passed near Hawley and Sanford's Mills, crossing on, or near, their dam, and continuing directly across a high ridge of land between there and Stamford.

Appearances are more favorable for continuing a line from Darien Landing farther north, crossing at the head of Hawley and Sanford's Mill Pond, and running diagonally along the eastern slope of the ridge. This location would increase the distance about ten chains, but it would enable us with the same grade to gain a higher elevation for the summit of the Road, and consequently, lessen the cut at that point. At Stamford village, our line is from ten to fifteen chains south of the main street, crossing Stamford river north of the landing; thence we pursue a south-west course for the distance of one mile, which brings us to the summit of the ridge west of Stamford; thence our line runs north of west, passing over a rocky, uneven surface, and crossing the head of a swamp near Old Greenwich; thence south-west, passing near the church, and crossing another ridge to Miamus river, over which our line passes between the two landings.

From Stamford to this point, on the route surveyed, there would be a succession of deep cuts and heavy embankments, which I do not hesitate to say, may be materially lessened, by continuing the line farther south, where the country presents a more uniform surface. From Miamus river, our line was conducted over a low flat, lying directly in our course to the head of Davis' Mill Pond. At this point, we commence the ascent of Puts' ridge, on the summit of which, we encounter a cut of thirty-two feet, falling off to grade on each side in a distance of five chains. This

point is twenty-eight miles from Bridgeport, and about three-fourths of a mile from Rocky Neck landing.

From Puts' ridge, our course is very direct through a natural ravine to the summit of the next ridge, where we have a short cut of twenty feet in depth, apparently free from rock; thence passing over a broken, uneven surface to the summit of the next ridge, where by a short cut of twenty-three feet in depth, we are brought to the valley of Byram river, on the east bank of which, opposite Sawpits village, our survey was terminated This point was found to be thirty miles and twenty-eight chains from our starting point in the city of Bridgeport. From Sawpits to Harlaem, I ascertained the distance to be about twenty miles, and from my knowledge of the country, I feel warranted in saying that the construction of a road between these two points would be entirely practicable.

The entire route from Bridgeport to Sawpits would be a succession of long straight lines, and easy curves, in no instance less than one thousand feet radius. My time being limited, an instrumental examination was made of one route only; although the features of the country are such, that at some poin's several routes appear to possess nearly equal advantages, each of which should be carefully examined. The following table will show the condition of the line, in respect to its grades, as they occur in passing from Bridgeport to Sawpits.

No. of Grades	Location.	Length of Grades in Chains.	Total distance from Bridgport Miles, Chains	Ascent per mile in feet.	Descent per mile in feet.
1	Water Street	24	0·24	Level	
2	Bridgeport and Fairfield line	36	0 60	20	
3	New-York and Boston Turnpike	100	2·00	Level	
4	Near Turnpike	24	2·24	30	
5	do do	4	2 28	Level	
6	Across Ash Creek	40	2·68		24
7	to station 71	56	3·44	Level	
8	Small Creek	24	3 68		20
9	in Road	32	4·20	Level	
10	Fairfield Village	36	4·56	20	
11	Mill Creek	76	5·52	Level	
12	near Southport	20	5·72	40	
13	do do	4	5·76	Level	
14	do do	36	6 32		40
15	do do	4	6·36	Level	
16	Gravel Ridge	16	6 52	30	
17	do do	28	7·00	Level	
18	do do	40	7·40	30	
19	do do	12	7 52	Level	
20	do do	32	8 04		30
21	Old Road	4	8·08	Level	
22	Green's Farms	36	8·44	40	
23	do do	4	8·48	Level	
24	Fairfield and Norwalk line	76	9 44		30
25	on Marsh	24	9·68	Level	
26	Cumpo Corners	80	10 68	20	
27	do do	4	10·72	Level	
28	Saugatuc River	28	11·20		30
29	in Swamp	52	11·72	Level	

No. of Grades	Location.	Length of Grades in Chains.	Total distance from Bridgeport Miles, Chains.	Ascent per mile in feet.	Descent per mile in feet.
30	In Swamp	4	11·76	20	
31	Summit of Ridge	80	12·76	40	
32	do do	4	13·00	Level	
33	Norwalk River	84	14·04		40
34	do do	12	14·16	Level	
35	Summit of Ridge	112	15·48	40	
36	do do	8	15·56	Level	
37	past Five Mile River	108	17·04		40
38	do do	4	17·08	Level	
39	on Short Rocks	44	17·52	40	
40	do do	8	17·60	Level	
41	on Salt Marsh	64	18·44		40
42	do do	4	18·48	Level	
43	Good Wife's River	24	18·72	30	
44	do do	12	19·04	Level	
45	past Darien Landing	20	19·24	40	
46	do do	4	19·28	Level	
47	Salt Marsh	36	19·64		20
48	Darien and Stamford line	24	20·08	Level	
49	Summit of Ridge	72	21·00	40	
50	do do	4	21·04	Level	
51	Stamford Village	72	21·76		40
52	do do	24	22·20	Level	
53	Stamford River	32	22·52	30	
54	Summit of Ridge	84	23·56	40	
55	do do	4	23·60	Level	
56	Old Greenwich	68	24·48		40
57	do do	4	24·52	Level	
58	Summit of Ridge	52	25·24	40	
59	do do	4	25·28	Level	
60	Miamus River	56	26·04		40
61	do do	8	26·12	Level	
62	in Meadow	28	26·40		40
63	do	4	26·44	Level	
64	in Swamp	28	26·72	20	
65	do	20	27·12	Level	
66	Davis Mill Pond	16	27·28		40
67	do do	8	27·36	Level	
68	Puts Ridge	44	28·00	40	
69	Past Road	24	28·24	Level	
70	Summit of Ridge	72	29·16	40	
71	do do	8	29·24	Level	
72	Byram River.	84	30·28		40

Recapitulation of Grades.

7	miles,	60	chains,	Level.		
2	"	24	"	20	feet ascent	per mile.
1	"	56	"	30	"	"
7	"	76	"	40	"	"
0	"	60	"	20	descent	"
0	"	40	"	24	"	"
1	"	56	"	30	"	"
7	"	56	"	40	"	"
30	"	28	"			

The following estimate is based upon a grading sixteen feet wide for a single track. The slopes to be one foot and a half base to one foot rise. Where rock occurs, the road bed is estimated at fourteen feet in width, slope half a foot, to one foot rise.

Embankments to be fourteen feet wide, grade with slopes the same as in earth excavation.

The face work of the masonry for large structures to be neatly hammer-dressed range work. and all to be of the most permanent character —The superstructures for the bridges are estimated upon Col. Long's plan, and in crossing navigable waters, ample provision is made in the estimate for draws of the most approved construction to admit the passage of vessels. Turnouts of suitable length are estimated for every five miles, and the road to be prepared for locomotive power. The estimate is confined to the route examined with the instrument, although I am perfectly satisfied a very considerable saving of expense may be made by the alterations referred to.

The estimate of grading will be given in sections comprising each a town through which the line passes, commencing at Bridgeport, and extending westwardly to its termination.

BRIDGEPORT SECTION, No. 1.

This section commences at the junction of Wall and Water-streets in he city of Bridgeport, and is sixty-four chains long.

Excavation,	$447 60	
Embankment,	364 80	
Culverts and Drains,	350 00	
Road crossings,	75 00	
		$1,237 40

FAIRFIELD SECTION, No. 2.

This section extends through the town of Fairfield, and is eight miles and fifty-six chains long.

Excavation,	$7,190 90	
Embankment,	14,549 76	
Rock,	5,516 00	
Bridges, Culverts and Drains,	12,120 00	
Road and Farm crossings,	520 00	
Grubbing,	158 00	
		$40,054 66

NORWALK SECTION, No. 3.

The length of this section is seven miles and sixteen chains, and includes the bridges across Saugatuc and Norwalk rivers.

Excavation,	$20,023 66	
Embankment,	20,477 81	
Rock,	25,148 00	
Bridges Culverts and Drains,	25,285 00	
Roads and Farm crossings,	430 00	
Grubbing,	912 00	
		$92,276 47

DARIEN SECTION, No. 4.

This section is three miles and forty chains long.

Excavation,	$4,001 58	
Embankment,	8,189 53	
Rock,	5,152 00	
Bridges, Culverts and Drains,	11,380 00	
Road and farm crossings,	170 00	
Grubbing,	235 00	
		$29,128 11

STAMFORD SECTION, No. 5.

Excavation,	$15,229 64
Embankment, - -	19,998 14
Rock, - - -	$16,052 00
Bridges, Culverts and Drains,	14,130 00
Road and Farm crossings, - - -	295 00
Grubbing, - - -	280 00
	$65,984 78

GREENWICH SECTION, No. 6.

This section is six miles and eight chains long, and terminates a Byram river.

Excavation, - - - -	$14,043 02
Embankment, - - -	42,577 52
Rock, - - - -	19,556 00
Bridges, Culverts and Drains, - -	19,010 00
Road and Farm crossings, - - - -	315 00
Grubbing, - - - -	526 00
	$96,026 54

RECAPITULATION.

Sections,	Length in miles and chains,		Amount.
Bridgeport, - - -	0	64	$1,237 40
Fairfield, - - - -	8	56	40,054 66
Norwalk, - - - -	7	16	92,276 47
Darien, - - -	3	40	29,128 11
Stamford, - - -	4	04	65,984 78
Greenwich, - - - -	6	08	96,026 44
	30	28	$324,707 96

Whole distance, 30 miles, 28 chains.

Whole amount as above, $324,707 96 = $106,99 12 per mile.

SUPERSTRUCTURE.

I assume as a model the ordinary wooden superstructure, having longitudinal sills five by seven inches; cross-ties eight feet long and six inches square, with a pine rail six inches square, surmounted by an iron plate, $2\frac{1}{4}$ by $\frac{5}{8}$ inches, secured by spikes and bolts. A superstructure of this kind, with all the materials of the very best quality, I estimate to cost, including turnouts, $5000 per mile.

RECAPITULATION OF COST.

Grading for single track, including turnouts, -	$324,707 96
30 miles, 28 chains of superstructure, at $5,000 per m.	151,750 00
Contingencies, Engineering, &c. - - -	30,000 00
	$506,457 96

or $16,688 25 per mile.

Although I have estimated for the wooden rail and flat bar, still I would recommend the edge rail, believing it to be sound economy to use it on a road destined to do such an immense amount of business.

A single track edge rail, with turn-outs, including right of way, and all expenses to prepare the road for Locomotive power, may be constructed for $21,000 per mile,

A brief description of the Rail Roads in progress, will show the vast importance of this project. There is every reason to expect, that within three years from this time, an uninterrupted line of Rail Road communication will be opened from New Haven to Boston and Maine; from

Boston and Bridgeport to Lake Erie, *via* Albany, with branches uniting with these main trunks at various points.

When this shall have been done, it is easy to conjecture the immense amount of business and travel that will concentrate at New Haven and Bridgeport, seeking the great commercial metropolis of the Union, through this channel.

I would refer to some of the resources that this road, when complete, will have for its support. The present amount of travel between New York, Bridgeport, and the intermediate points, for four or five months in the year, is about 250 daily each way; for the residue of the year about 100. This, however, does not include the travel between Sawpits and New York. I have not been able to ascertain the amount of travel between the country east of Bridgeport and New York, but from the number of Steam Boats engaged on the Sound, almost exclusively in the transportation of passengers, we can readily conceive the number must be several hundred each way daily. During the Summer, this travel would be divided between the Steam Boats and Rail Road. But for several months in the year, a large proportion of it would seek the Rail Road.

In proof of this, I would refer to the New Jersey road, extending from Jersey City to New Brunswick, where, notwithstanding there is a daily Steam Boat from Newark, Elizabethtown and New Brunswick, their through passengers amount to about two hundred per day each way, and their way passengers to six or eight hundred.

It is presumed that a portion of the immense travel between New York and Albany, even in summer, would, for the sake of variety, take this route. The whole distance could easily be accomplished in nine hours, including all stoppages.

But whatever doubts there may be on the summer, there can be none on the subject of the winter travel between New York and Albany, which probably averages one hundred per day each way, and no doubt would be quadrupled on the completion of this route through to Albany.

The immense amount of water-power on the Housatonic, which on the completion of the Housatonic Railroad will be brought into notice, must, ere long, be improved and applied to manufacturing purposes; in consequence of which a large increase of way travel may be expected.

But independent of all this, there are other considerations which demand the construction of this road. The great chain of Railroad from Maine to New-Orleans, which is now progressing with a rapidity equalled only by its importance, would be incomplete without it.

It will be demanded for the transportation of the United States Mail, for which Railroads are so eminently calculated; possessing a superiority, as regards speed and certainty, over any other mode of conveyance.

I will not attempt a description of the importance of this Road, as connected with the interests of New-York city. From the well-known intelligence, energy and enterprise of the citizens of New-York, it may be expected they will duly appreciate the importance of an uninterrupted communication, at all seasons of the year, with such a vast extent of country.

Where, I would ask, is there a Railroad project whose benefits, when completed, would be so widely diffused, or that promises such a rich reward to the Stockholders?

My acknowledgments are due to B. B. Provoost, Esq., and Robert Ogilby, for the zeal and energy with which I was seconded by them in the accomplishment of the survey. Respectfully submitted.

R. B. MASON, *Chief Engineer of the Housatonic Railroad.*

First Russian Railroad.

The celebrity of the first Russian Railroad has rendered it an interesting work to Engineers; a desire is felt to ascertain the details of its construction, and we therefore give nearly the whole description, as taken from a published statement politely furnished us by the Chev. von Gerstner.

We have also been favored by an examination of the map of the road, and plans of the buildings constructed. From the contiguity of these to the Royal Palace and grounds, more architectural display was needed than we are apt to find about our own railroads. They have furnished an opportunity, however, to the gentleman constructing the work, to prove himself an able architect as well as engineer.

There are several points which we commend to the special attention of our Engineers, viz. :—The width of the track—the space cleared on both sides of the track—the immense travel in the vicinity of St. Petersburgh —and the speedy completion of the work.

First Russian Railroad from St. Petersburg to Zarskoe-Selo and Pawlowsk, established by imperial decree of 21st March, 1836, and carried into execution by a company of shareholders in Russia, England and Germany. Translated from the German.

Founders and Directors of the Company.—His Excellency the Count Alexis Robrinsky, Chamberlain to his Majesty the Emperor; Benedict Cramer, Esq., Merchant, Councillor of Commerce ; J. C. Plitt, Esq., Merchant, Consul to the Free Town of Frankfort-on-Maine; the Chevalier Francis Anton Von Gerstner, who is also Directing Engineer.

Capital.—Three Millions of Bank Note Rubles, in 15,000 Shares of 200 Rubles (about £9 Sterling) each, with the right of raising an additional 500,000 Rubles, if required, by the issue of 2500 new Shares.

Explanation.—1 werst=500 fathoms=3500 English feet.—1 English mile=about 1½ werst.—1 English ton=62$\frac{1}{10}$ pud.—£1 sterling=23 bank note rubles.

The Reports on the Zarskoe-Selo Railroad, which from time to time have appeared in the Russian papers, and from thence have been copied into the foreign journals, have excited considerable interest in the public, particularly in Germany and England. No undertaking of the same class has hitherto made such rapid progress as this railway, which, called into existence by the especial patronage of the Emperor of Russia, and endowed with most extensive privileges, precludes all doubt of its proving eminently successful and advantageous to the shareholders. In a few days subsequent to the Imperial Grant being obtained, the company of shareholders was formed, and the whole capital (three millions of rubles) subscribed. The payments of the calls upon all the shares issued, were made with punctuality, and no single instalment remained in arrear. Within six months and six days from the time the decree received the imperial sign-manual, the requisite supply of rails and materials, carriages and machinery, was obtained from England ; most of the works on the

entire length of line, 25½ wersts, were completed, the rails partly laid down, and three wersts opened by horse power. Six weeks later the opening of a distance of 7½ wersts, with locomotives, took place; and this summer (1837) the whole of the line, from the centre of the capital to the terminus in Pawlowsk, will be opened.

Thisrapid progress of the undertaking, which in other countries would have been the work of several years, naturally excited the attention both of natives and foreigners.

That portion of the English public which takes a general interest in railways, expressed a desire to obtain the Reports which have hitherto appeared, that they might be enabled to investigate the circumstances that led to so extraordinary a result in Russia; another portion, better acquainted with the favorable state of the Russian share market, with a view to partake in this new speculation:—but as the publications of the Chevalier von Gerstner—viz.

Memoir on the advantages of a Railroad from St. Petersburg to Zarskoe-Selo and Pawlowsk, 20th March, 1836.

First Report on the progress of this Railroad, 20th July, 1836;

Second Report on the same, 22nd September, 1836;

have for some time been out of print; the

Third Report, 29th January, 1837, which has reference to the preceding, would hardly be understood by many readers. The purport of the present paper is, therefore, to lay before the public in this country a clear statement of facts relative to the Zarskoe-Selo railway, to assist them in forming a correct opinion of the enterprize, and in entering into it, as well as into other manufacturing concerns about to be carried into effect in Russia. It will tend, at the same time, to give a more expanded view of the internal constitution of that colossal empire, and to correct the erroneous opinions that have been induced by a defective knowledge of its actual condition.

Peter the Great, the immortal founder of the power and greatness of the Russian empire, felt how necessary to its welfare was the improvement of its communications; he had witnessed in Holland the beneficial influence of canal traffic; he visited the interior of his empire, and himself planned the whole of the water communications which were, either during his reign or afterwards, carried into execution. This Sovereign introduced *Canals* because, in the then existing state of knowledge, they were considered as the most perfect channels of internal communication. Alexander I, introduced artificial *Roads.* He commenced with the first turnpike road from St. Petersburg to Moscow, a distance of about 700 wersts, the smallest portion of which only was accomplished when death overtook this monarch; but his successor, the reigning Emperor Nicholas I., carried out the project; in a few years finished the road to Moscow; and caused surveys to be made for a complete system of roads, intended to intersect the whole interior of the empire, which, under his happy reign, is now making such rapid advances in prosperity.

The progress which *Railroads* had made in modern times did not escape the scrutinizing view of the Sovereign. The Chevalier von Gerstner went to Russia in August, 1834, with the intention of visiting the interior of the country, and informing himself respecting its manufactories and mines. The Emperor Nicholas heard of this, as well as that so early as

7th September, 1824, the Chevalier had obtained a privilege from the late Emperor Francis of Austria, to construct a railroad between the Moldau and Danube; that for four years, up to 1828, he conducted the works on this line, comprising, with its continuation from Linz to Gmunden, a total length of 130 English miles, over which the traffic continues in summer and winter without interruption. The Emperor in consequence, in September, 1834, expressed a desire to see a line of railway from St. Petersburg to Moscow executed, if possible, by a company of shareholders.

After the Chevalier von Gerstner had, in the beginning of 1835, finished his tour to the manufacturing provinces, he was presented at the Court of St. Petersburg, when the Emperor, with great earnestness, and with the penetration for which he is so remarkable, expressed himself strongly as to the advantages that would result from the introduction of railways into Russia, and the extraordinary privileges that the first undertakers might expect.

The Chevalier von Gerstner in consequence proposed to commence with two short lines, the first from the interior of St. Petersburg to the towns of Zarskoe-Selo and Pawlowsk, and the second from the same point in the capital to Peterhoff and Oranienbaum.

The negociations for the grant lasted to the end of the year 1835, when, on the 21st December, the President of the Council, in the name of the Emperor, communicated to M. von Gerstner that he was thenceforth invested with the *exclusive* personal privilege of *incorporating shareholders for the execution of both railways.*

The Chevalier von Gerstner hereupon joined the three other Directors and Founders of the company of shareholders, whose names have been given above, for the execution of the first line, from St. Petersburg to Zarskoe-Selo and Pawlowsk, whilst he reserves to himself the right of forming the company for the line to Peterhoff.

The demand for shares, on the undertaking of the enterprize being made public, was so great that the first 15,000 shares, or the original capital of three millions rubles, were subscribed for almost immediately; chiefly by the Russians and naturalized Germans, although persons residing abroad may participate, without any restriction. The latter may either appear in person at the general meetings, or be represented by their agents, and receive their dividends the same as the Russian subjects, without any deductions or the payment of any duties to the state.

The Imperial Grant for the Zarskoe-Selo railway is dated 21st March, 1836. The privileges thereby conceded to the company are very considerable, such as were never granted to any railway company in any country before. The execution of the railway is regarded as if undertaken immediately by the Crown; the Crown lands have been gratuitously ceded to the company; the farmers holding lands that were required, have been appointed to other ground, and are compensated by the Crown for any loss sustained by the transfer; lands or buildings, the property of private individuals, must be surrendered to the company, either by voluntary agreement or at a price to be determined by judicial valuation; but to prevent the obstruction of the works, the company, by depositing a sum of money about equal to the purchase-price of a similar plot of ground or tenement in the vicinity, have the power to take possession of such lands or tenements before the termination of the appraisement. The valuation being determined, the balance of the amount due is paid to, or received from the parties.

The company are at liberty to erect any description of buildings re-

quisite for the railway traffic, for 100 fathoms on each side of the railway, except in the Artillery Ground, through which the line passes, and for the acquisition of which the same privileges have been granted as for that of the rest of the line. The removal of the battery, rocket manufactory and other military buildings intersected by the line, is to be effected by the company, at their cost, to another quarter. In this manner the railway without the town forms an uninterrupted straight line for 24 wersts. Within the town the straight line is only warped into two gentle curves, by following the course of the Wedenskoi canal.

The medium rise of the whole line is 1 in 1028, and the extreme 1 in 504. The railway terminus in the town is at the junction of the Wedenskoi with the Fontanka canal, on a piece of ground 80 fathoms by 42½ in breadtn, which has partly been purchased and partly ceded by the Crown. From this spot to the new boundary of the town on the Ligofka, the railway measures about 1½ mile, and will therefore, for that distance, *run within the capital*, a circumstance of the utmost importance, as affecting the number of passengers or the amount of traffic. The terminus at the other end is situated 550 fathoms within the Great Park of Pawlowsk, the property of his Imperial Highness the Grand Duke Michael Pawlowitsch. The company have been permitted to erect, in some of the finest parts of that park, several buildings for the reception and entertainment of the public; and at Zarske-Selo they have been allowed to establish an hotel at the railway station.

The company have the right to purchase the iron for the whole line, abroad, and to import the same *duty free*, provided no Russian iron work should undertake the delivery in the required quality, form, and time, and at most at 15 per cent advance upon the price at which the iron might be imported into St. Petersburg, from foreign countries. The company are further empowered to import the locomotive engines, railway carriages, and all other machinery and requirements, *duty free*.

The company are not bound to any fixed fares for the conveyance of passengers, or rates for the carriage of goods, but are at liberty to fix them at discretion. The railway remains *for ever* the property of the company: during the first ten years no one can make a railroad in the same direction; and during the same term of ten years the company are exempted from the payment of rates and taxes of every description, either to the Post Administration or any other authority The capital of the company is covered by 15,000 shares of 200 bank note rubles each; if necessary, 2500 more shares may be issued for raising the reserve fund of 500,000 rubles; all the 17,500 shares, however, participate alike in the profits of the undertaking. *The number of shares can in no case be augmented.*

Eight days after the grant had been made out, the Chevalier set out from St. Petersburg for England and Belgium, for the purpose of ordering the necessary rails, engines, carriages, and other railway machinery, as no one could be found in Russia to contract for these materials in the stipulated time.

It was exceedingly difficult to obtain them in England last year, as the iron works there, in consequence of the many English and American orders, were occupied literally night and day, and most of them had employment for a year or two in advance, in consequence of which the price of rail bars had been raised upwards of 40 per cent. within a twelvemonth. Another difficulty arose from the Chevalier having altered the *width* (or the distance of the two rails upon which the carriages run) of the Russian

railroad, from that established in England. On the old English railroads only goods of small bulk and great weight were transported, such as iron, coals, stones, bricks, &c., but not sheep's wool, hay, straw, or fire wood. In 1822, when the railway between Stockton and Darlington was begun, which was first intended for a general traffic of passengers and goods, Mr. George Stephenson, the engineer, established the breadth of the track between the rails at 4 feet $8\frac{1}{2}$ inches English, as being the width of the track of carriage-wheels on high roads. Experience has shown how inconvenient this arrangement is for the locomotive engines, which in England, usually of 15 to 18 horses' power, are by this narrow gage confined within about four feet, which *is by far too little for such an engine.* The driving wheel can at most have but a diameter of five feet, as otherwise it would lurch too much; in order, therefore, to do 30 miles an hour, it must make 168 *revolutions* in a minute The strain and wear and tear of all the parts of a locomotive, by reason of the quick motion of the driving wheel, and more particularly the cramped arrangement of the individual parts, are therefore very considerable.

The disbursements in the coaching and carrying departments on the Liverpool and Manchester railway, upon an average of the last three years, amounted to 44 per cent., and the repairs of the locomotive to 56 per cent. of the total expenditure, originating in their wear and tear as a tractive power. This charge must naturally be far less in a wider gage. If cattle and bulky materials, such as sheeps' wool, straw, hay, firewood, travelling carriages, &c., are to be conveyed, the load cannot be stowed between the wheels, if the gage is only 4 to $8\frac{1}{2}$ inches, but must be placed in a box or on a platform 6 to 8 feet wide, by which, the base being only half as large as the superstructure, great lurching is necessarily occasioned, particularly at high velocities; and moreover, especially in rough weather, high loaded waggons, with a confined base, are apt to have the flange of the wheels rub up against the rails, thereby occasioning great increase of friction, wear and tear. The trains generally run the distance between Manchester and Liverpool in $1\frac{1}{4}$ to $1\frac{1}{2}$ hour, whereas in a high wind those laden with cotton wool take three hours for the journey, which would not be the case if a wider gage had been adopted. Increase of axle friction cannot take place on a wider gage, as in all railway carriages the friction is now no longer between the wheels, but on the outside, on the projection of the axle through the wheel.

These and other reasons induced the Chevalier von Gerstner to *adopt a gage of six feet English between the rails*; but the consequence was, that for the locomotive engines, turnplates, and machinery, new drawings and models had to be prepared, before the construction of the machinery could be commenced. The deliveries thereof last year were in consequence attended with considerable difficulty; but connexions of many year standing, which the Chevalier von Gerstner had in England, enabled him to overcome these difficulties, and in the Third Report there occurs the following account of the rails, chairs, &c. imported duty free into Petersburg.

Besides the above rails, a small parcel, ready in autumn, remained behind in England, for want of an opportunity to ship it, and cannot arrive in St. Petersburg until the spring.

The weight of the rails delivered is	1727	tons	6	cwt.
" " pedestals and blocking pieces	656	"	4	"
" " pins	38	"	8	"
" " wedges	16	"	1	"

With respect to the rails, it may be observed that they are of a parallel form, have the top and bottom shaped alike, and weigh 65 lbs. per yard; the general length of a rail is 15 feet, though some few are 12 feet.

Independently of the iron masters contracted with being of the first respectability, the punctuality with which the rails, chairs, &c. were delivered, may perhaps be partly ascribed to the circumstance mentioned in the Chevalier von Gerstner's First Report, that to each contract a penalty of 5*l.* per day for every instance of non-delivery was attached; on the other hand, the iron masters received a considerable payment on account —upon an average, one-third of the whole amount of the contract. In making the rails from the rough or puddled bars, they were cut into lengths, heated in the welding or balling furnace, and then rolled into rail bars, and consequently were what is called thrice worked, or best quality.

The Chevalier von Gerstner, besides these, ordered six locomotive engines in England, of which, three were to be delivered in the autumn of 1836, and the remainder in the spring of 1837. The prompt delivery of the former was insured by a penalty of 500*l.* if the work was delayed even for a single day beyond the time. The locomotive and tender of Messrs. Robert Stephenson & Co., in Newcastle on Tyne, cost 1875*l.*; that of Mr. Timothy Hackworth, of New Shildon, 1700*l.*, both inclusive of charges to the vessel. Mr. Cockerill delivered a locomotive and tender at St. Petersburg for 40,000 francs The diameters of the steam cylinders were 14 inches, whereas those in the English railroads are only 12 inches: the power of the Russian engines is consequently one third greater than in the English, which have thirty to thirty-five horses' power.

To be continued.

Specification of a Patent granted to ARCHIBALD RICHARD FRANCIS ROSSER, *of New Boswell Court, in the County of Middlesex, Esquire, for Improvements in Preparing Manure, and in the Cultivation of Land.*—Sealed August 2, 1837.

To all to whom these presents shall come, &c. &c.—*Now know ye* that in compliance with the said proviso, I, the said Archibald Richard Francis Rosser, do hereby declare the nature of the invention is described and ascertained, in and by the following statement thereof (that is to say:—

The invention relates to a mode of reducing into manure, and applying the same to the cultivating and fertilizing of land, whereby land may be dressed, cultivated, and manured with greater advantage than has heretofore been practised, not only broom, heather, furze, rushes, and other vegetables not hitherto used for making manure, as being deemed too difficult of decomposition, but also vegetables and weeds, such for instance as couch grass, which it has hitherto been considered dangerous to introduce into manure, and the vegetating powers of which are by the invention totally destroyed. The principal object effected by the invention is the production of a rapid fermentation, the degree of which may be regulated nearly at pleasure, whereby the substances to be converted into manure are speedily and uniformly decomposed. The inventor found it very convenient and effectual for facilitating the conversion of substances into manure, to prepare a liquid beforehand, which he called *eau et saturer*, and which I will call saturating water. This saturating water may be conveniently prepared thus; form a tank or a water tight pit, proportion-

ed to the dimensions of 12 feet long, by 6 feet broad, and 6 feet deep; fill the tank to the extent of half its depth with water, throw in such herbaceous or even woody plants as may be within reach, taking care to make use in preference, of those containing the most unctuous and mucilaginous parts. With these plants and the water the tank is to be filled up to the extent of three-fourths of its depth; add, of the nearest earth or soil, sufficient only to leave one foot in depth of the tank unoccupied, then put in 10 pounds of unslacked lime and 5 ounces of sal ammoniac. The tank may afterwards be filled and kept full with kitchen water or any sweepings, dead animals, spoiled provisions and filth from the dwelling-house. The contents of the tank should be stirred together from time to time. Should much unpleasant odour be evolved or insects be produced, more unslacked lime should occasionally be added. The next thing to be done is to prepare a smaller water tight vessel, tank, or pit, into which are to be thrown a sufficient quantity of the saturating water to dissolve or mix the ingredients after mentioned, or if there is no saturating water prepared, water as impure and putrid from animal and vegetable substances as can be conveniently procured.

The inventor calls this water mixed with the matters next mentioned, a lessive. By the words fecal matters or fecal substances hereafter used, I mean human ordure. About 130 gallons of the lessive may be prepared for the conversion of 1000 lbs. of straw or 2000 lbs. of green woody fibrous vegetable substances, into 4000 lbs. of manure. The lessive, with the sufficient quantity of saturating water or impure water before mentioned, may be composed of the substances following, and in about the following proportions, that is to say, 200 lbs. of fecal substances and urine (the greater the proportion of fecal matter the better), 50 lbs. of chimney soot, 400 lbs. of powdered gypsum, 60 lbs. of unslacked lime, 20 lbs. of wood ashes not lixiviated, 1 lb. of sea salt, 10 ounces of refined salt-petre, and 50 lbs. of what the inventor called levain d' engrais, and I call leaven of manure, being the last drainings from a preceding operation where there has been one. The saturating water is to be well stirred till it is thick, and a portion of it is to be immediately poured into the lessive tank into which are to be thrown the lime, the soot, then the ashes, then the fecal matters, the salt, and afterwards the saltpetre. The gypsum is to be thrown in powdered, little by little, always stirring the mixture lest it should cake; when the whole is well mixed by stirring, the leaven of the manure is to be added.

Although I have mentioned various primary or preferable substances for the composition of the lessive, yet where these cannot be used with due regard to economy, substitutes may be employed. For the fecal substances and urine, 250 lbs. of the dung of horses, oxen, cows, or pigs; or 100 lbs. of the dung of sheep or goats, for the chimney-soot; 100 lbs. of the burnt, baked, or roasted earth, for the gypsum; the same weight of river mud, hill-side mud, sea-mud, fat earth from woods or forests, marl or dust, or mud, of the high road; for the wood ashes not lixiviated, 50 lbs. of wood ashes lixiviated, or two pounds of potash; for the sea-salt, 100 lbs. of sea-water; for the refined saltpetre, any quantity of rough saltpetre or common saltpetre, or mother water of saltpetre, containing 10 ounces of pure saltpetre. Whenever the quantity of a lessive fails for a making, or runs short, it is to be made up with the saturating water, and that again with water, always using the most impure and putrid from animal and vegetable matters that can be obtained. In the place where the substances to be converted into manure are to be heaped for that pur-

pose, the surface of the ground is to be rendered impervious to liquids by beating, paving, or otherwise, in such a manner as that the liquids running from the heap may flow unabsorbed into pits or reservoirs placed or constructed at a lower level. For making the heap, straw may be used; whole furze broom and other woody stalks may with good effect be cut into lengths of from 6 to 8 inches, or bruised, that they may pack the closer, and retain the lessive the better. It is very advantageous to throw the vegetable substances to be reduced into manure into a vessel, tank, or pit, containing a quantity of the lessive, the lessive having been previously made as muddy as possible by stirring. The substances are to be trodden or beaten among the lessive; and as fast as they are well soaked and slimed all over, they are to be thrown upon the heap. The heap may be conveniently made 7 feet high, and upon every layer of a foot deep, there should be thrown in a drenching of the lessive, first stirring it well. When the heap is raised to its full height, the muddy sediment of the lessive (which has not been stirred up into the liquid) is to be spread equally over the top surface of the heap. The top of the heap should then be covered with straw, old planks, branches, or herbage, or any other suitable matters. While the heap is making, it should be beaten or trodden down, so as to make the substances of which it is composed lie close and compact; and when it is finished, it should be beaten all round with the same view. At the end of 48 hours from the completion of the heap, a fermentation of from 15 to 20 degrees of heat, by Reaumur's scale, has been found to have taken place; and on the following day it has generally attained from 30 to 40 degrees of Reaumur On the third day, the top of the heap is to be opened to 6 inches deep with a fork, and the sediment thrown on the top is to be turned over, and another good drenching with the lessive is to be applied to the heap, which is again to be immediately covered up; about the seventh day, holes about 6 inches distance from each other are to be made with a fork to the depth of 3 feet, and another drenching is to be applied, the heap being afterwards covered up again. About the ninth day, another drenching is to be applied through new and somewhat deeper holes, and the heap is to be again covered up. After the lapse of from 12 to 15 days from the making of the heap, the manure will be fit to spread. The fermentation is stopped by an excessive drenching, or by opening out the heap. If the materials of the heap are straw only, the fermentation may be stopped at 55 degrees of heat, otherwise it may be allowed to proceed to 75 degrees. All the draining should be carefully collected and used over and over again, for the drenchings and residue should be preserved for subsequent makings. In all processes of fermentation, it necessarily happens that variations of heat and time take place according to the temperature of the atmosphere, and the materials acted upon, and other causes And it is advisable not to make the heap in very cold weather; but the inventor found that the process here laid down was the best for suitable fermentation, which, after numerous experiments made during many years, he could devise. The experienced farmer will, in the composition of his lessive, have regard to the nature of the soil to which the manure is to be applied, and put into the lessive, more or less of lime, or the alkalies for instance, according as the soil is of a warmer or colder nature.

The invention consists in the composition of the lessive and the process of repeatedly using the lessive for producing fermentation, which may be regulated nearly at pleasure, although the proportions of the materials composing the lessive may be reasonably varied, and although such vari-

ations may in some degree retard the required decomposition of the heap. —In witness whereof, &c

Enrolled February 2, 1837.

Abstract of Papers read at the Institution of Civil Engineers.

"Additional Remarks on the Canal Lifts of the Grand Western Canal, by James Green."

If the trade of the canal were all downward, there would, by the use of these lifts, be carried from the lowest to the highest level of the canal a quantity of water equal to the loads passed down

Mr. Green stated, in reply to several questions, that in some parts of the canal it had been found impracticable to get a sufficient drain to empty the chamber---they were compelled therefore to use a half lock of eighteen-inches' fall; that there were seven lifts and one inclined plane on the canal, effecting a rise of 262 feet in eleven miles. That he should not recommend them as applicable to boats of more than twenty or thirty tons. The width of larger boats was an obstacle. They were extremely advantageous for narrow canals; for boats of fifty or sixty feet in length, and about thirty tons.

Mr. Parkes remarked, that he considered the question of narrow canals as a most important one—the advantage to be derived from narrow canals was a subject to which sufficient attention has not been paid.

The President called attention to the remarks in Mr. Green's paper, respecting the quantity of water carried up from one level to another in a downward trade wherever these lifts are to be used; then a coal country on a high level may supply itself with as much water as it sends down coal.

The subject of inclined planes being alluded to, especially those of the Morristown Canal, of 200 feet each, where a rise of 1,600 feet is effected by eight inclined planes, Mr. G. remarked that more water and time must be expended, the friction and length being much greater. In the lifts there was only as much water consumed as was equal to the load, but that he should not consider them as practically applicable to more than sixty or seventy feet. Favorable levels with ascents of more than sixty or seventy feet could seldom be found; could he have had the choice of the line in this particular instance, he should have effected by four lifts the rise for which seven are now employed.

"Professor Willis, on the Teeth of Wheels."

The geometry of this subject may be considered as complete, but it appears that important additions may be made to its practical applications. The general problem is, having given a tooth of any form, to determine one which shall work correctly with it. The method of effecting this may be shown in a simple practical manner. The curve to be traced out, which is the shape of the required tooth, is the locus of the intersections of all the outlines of the tooth in every one of its positions. The motion produced by the mere contact of the curve so traced out with the given tooth will be uniform. This then is a practical mode of showing the practicability of the problem.

The epicycloids and involutes have hitherto, from the facility with which they can be described, been almost universally employed. and practice has been confined to the class of epicycloids which work correctly with straight lines or circles. The defect under which such wheels labor is, that a wheel of fifty teeth of the same pitch will not work correctly with a wheel of one hundred teeth of the same pitch; since the diameter of the describing circle by which the epicycloid is formed, must be made equal to the radius of the pitch circle of the wheel with which the teeth are to work, and will therefore be twice as large in the second case as in the first. Also, if the teeth be epicycloids, generated by a circle whose radius is equal to that of the wheel with which it is to work, which is equally correct, the same remark applies.

This defect was of no great consequence when the teeth were wooden; but is of great consequence in iron wheels, since the founder must have a new pattern of a wheel of forty feet for every combination that it may be required to make of this wheel with others. It is desirable that the teeth of wheels be formed so that any tooth may work correctly with any other of the same pitch. This is the case with involute teeth, but the obliquity of the action is an objection to their introduction. The requisite property may be given to epicycloidal teeth, by employing the following proposition. If there be two pitch circles touching each other, an epicycloidal tooth formed by causing a given describing circle to roll on the exterior circumference of the first, will work correctly with an interior epicycloid formed by causing the same describing circle to roll on the interior circumference of the second.

From this Professor Willis deduces the corollary, that if for a set of wheels of the same pitch, a constant describing circle be taken and employed to trace those portions of the teeth which project beyond each pitch line by rolling on the exterior circumference, and those which lie within it by rolling on its interior circumference, then any two wheels of the set will work correctly together.* This corollary is new, and constitutes the basis of the system already alluded to.

It only remains to settle the diameter of this constant describing circle. The simplest considerations serve to show that the diameter of the constant describing circle must not be greater than the radius of the pitch circle; hence, as a convenient rule, make its diameter equal to the radius of the least pitch circle of the set. This rule is perfctly general, applying to racks and large wheels, as well as annular or internal wheels. The simplicity of this above the old system is obvious, for on the old every epicycloid requires two circular templets; also there must be as many templets as pitch circles in the set, whereas on this system but one describing templet is required.

For machinery in which the wheels move constantly in the same direction, the strength of the teeth may be nearly doubled for the same quantity of material, by disposing it so that the backs are an involute, or the arc of a circle, the acting faces being of the usual form.

In the preceding the exact forms have been described; the author then proceeds to ascertain forms sufficiently accurate for practice, and which

* For there is both before and after passing the line of centres an exterior epicycloid working with an interior epicycloid; for before passing the line of centres. the part of the driving tooth *within* the pitch line works only with the portion *without* the pitch line of its follower: and after passing the pitch line, the part of the driving tooth *without* the pitch line works with some portion of the following tooth which is *within* the pitch line.

are arcs of circles. Euler suggested the substitution of arcs of circles of curvature instead of the curves themselves. The portion of a curve employed in practice is so small that a circular arc is sufficiently accurate provided the centre and radius with which it is struck be determined by some more accurate method than by mere trial. With this view Professor Willis was led to investigate a method in which the nature and properties of curves proper for teeth are entirely neglected, and a simple construction shown by which a pair of centres may be at once assigned for a given pair of wheels, whence arcs may be struck that will answer the purpose of enabling these wheels to work correctly together.

The nature of the motion produced by the pressure of one circular arc against another, is then examined and reduced to that of a system of three rods, the middle one of which is jointed to two others, moveable at their other extremity about a fixed centre; and a simple construction is arrived at by which we may always find a pair of centres from which two circular arcs may be struck through any point, which will drive each other truly for a small distance on each side of that point. This point, when the side of a tooth consists only of a single arc, should be on the line of centres. It is however more advantageous that the tooth should consist of two arcs, for then there will be two points at which the action is exact—one a little before reaching the line of centres, the other a little after passing it.

From these investigations the author was led to construct an instrument fer setting out the teeth of wheels, which may be used with perfect facility by the workmen, and which has been termed an Odontograph; the application of which is fully described. The paper contains many practical observations connected with this subject, tables, &c., and concludes with some directions for ascertaining the correct form of cutters.

The following are the total number of lockages at lock No. 26, for the months of August, September and October, in each of the four last years, viz:

1835,	boats and cribs		10,722
1836,	do	do	10,781
1837,	do	do	8,447
1838,	do	do	11,229

Inerease for 3 months in 1838, over 3 months in 1837, *two thousand and sevne hundred and eighty-two lockages.*

The lockages on the Erie canal for the months of October, 1838, considerably exceed the number of lockages for the same month in any previous year since the canal was navigable.—*Argus.*

Errata in the Description of the Long Island Railroad.

Page 176 —Sixth line from bottom, omitted, "*the public.*" "as far as the public,"
177.—The first and second columns of the 1st table are misplaced.
178.—13th line from top, "ordinarily by *these* openings."
179.—2d line from the top, "tested by *me.*"
179.—11th line from bottom, "ground sill is *four* inches."
179.—9th line from bottom, "sills *or* the rails.
182.—9th line from bottom, "the *one* end of the rail."
215.—21st line from bottom, "estimated at *fifteen* or twenty cents."
217.—1st line from top, "of annual expense, (omit *a*).
244.—8th line from top, "*J*uniperus."
245.—20th line from top, "the same *ad*vantages would."
245.—21st line from top. "which *this* advantage."
The bottom line of page 246 is out of its place, the 15th and 16th lines from the top of 247 should follow instead, and the bottom line of 246 thereafter.
247.—15th line from bottom, "Baltimore and *Susquehanna.*"
243.—15th line from bottom, "which is 3 1-10 lbs.

NO[illegible]

[illegible] the numb[illegible] [illegible] and INDEX fo[illegible]

[illegible] on the cover [illegible] to those wh[illegible] number [illegible] forwarded, with the [illegible] also Nos. [illegible] and 9, in order t[illegible] the amount of the bills forwarded with[illegible] alternative of [illegible] our list th[illegible] We now forward Nos. Ten and *Eleven* [illegible] those whose [illegible] unpaid, that [illegible] amount due [illegible] much rather [illegible] one—but we [illegible] hereafter keep th[illegible] subscription is paid.

ENGINEERS' OFFICE, BALTIMORE & OHIO RAIL ROAD.

CONTRACTORS for Graduation, Masonry and Bridging, throughout the country, are informed that in all the month of March, 18[illegible] the part of the Baltimore and Ohio Rail Road between Harpers' Ferry and Cumberland, is expected to be finally located and ready for contract. The distance between those places is about one hundred miles upon the line of the Rail Road, which will be principally upon the Virginia Shore of the Potomac river.

The graduation will require the removal of upwards of [illegible] cubic yards of material; the bridges will contain about 36,000 perches, and the Culverts and Walls about 107,0[illegible] perches of Masonry; the aggregate length of the Bridge Superstructure will be about [illegible] feet. The road bed will be graded for a double track throughout the line. A Tunnel of about 1000 feet in length will form part of the work. As it is intended to press the work forward with great activity, no proposal for any portion of it will be accepted from any person who is not able to give the most satisfactory security for [illegible] prosecution of his contract, and its faithful performance. The customary specifications and plans of all parts of the work, will, it is expected, be ready at the Office of the Company in Baltimore, about the first of April [illegible]. Of this, more particular information will be given by timely advertisements. By order of the President and Directors.

BENJ. H. LATROBE,
Engineer, [illegible] & Construction.

TOPOGRAPHICAL DRAWING.

For instruction in this and other branches of Drawing useful to the profession, apply at this office.

NOTICE TO RAIL ROAD CONTRACTORS.

[illegible] proposals will be [illegible] Xenia, until [illegible] for the grub[illegible] [illegible] bridging.

[illegible] *Little Miami Rail Road*, [illegible] Xenia south to the line of [illegible] counties.

[illegible] will be received at [illegible] Cincinnati, until the [illegible] for the grubbing, grading [illegible] bridging of [illegible] of the same [illegible] [illegible] Columbus, [illegible] Mills, [illegible]

[illegible] August [illegible] the work [illegible]

[illegible]